After encountering broadcast interference in the ubiquitous µBITX transceiver, AC8GY designed a BCI filter that he discovered did even more than he expected. And it can be used with virtually any of the inexpensive QRP transceiver kits that are so popular today.

A BCI Filter With a Surprise

BY ALBERT F. PETER,* AC8GY

While experimenting with our JackAl system for the µBITX transceiver,[1] I noticed a strong broadcast station presence across the spectrum for this dual conversion receiver. I do know that some other inexpensive transceivers (e.g., Forty-9er, Frog Sounds, Pixie, etc.) have similar issues. This article presents an inexpensive way to solve the broadcast interference problem for any of these rigs by building a 7-pole BCI filter. Even if your junk box is empty, you can build this filter for less than $5.

I can hear you saying: "Oh, great, another BCI filter article." However, there were a couple of surprising discoveries during the process of killing off the BCI via the filter presented here. More on that in a minute.

* *739 Stonehill Run, Cincinnati, OH 45245*
email: <albertfpeter@gmail.com>

The Problem

With an end-fed 80-meter antenna and efficient ground system, interference from broadcast stations from 550 kHz to 1.6 MHz was evident as background in the µBITX audio. In

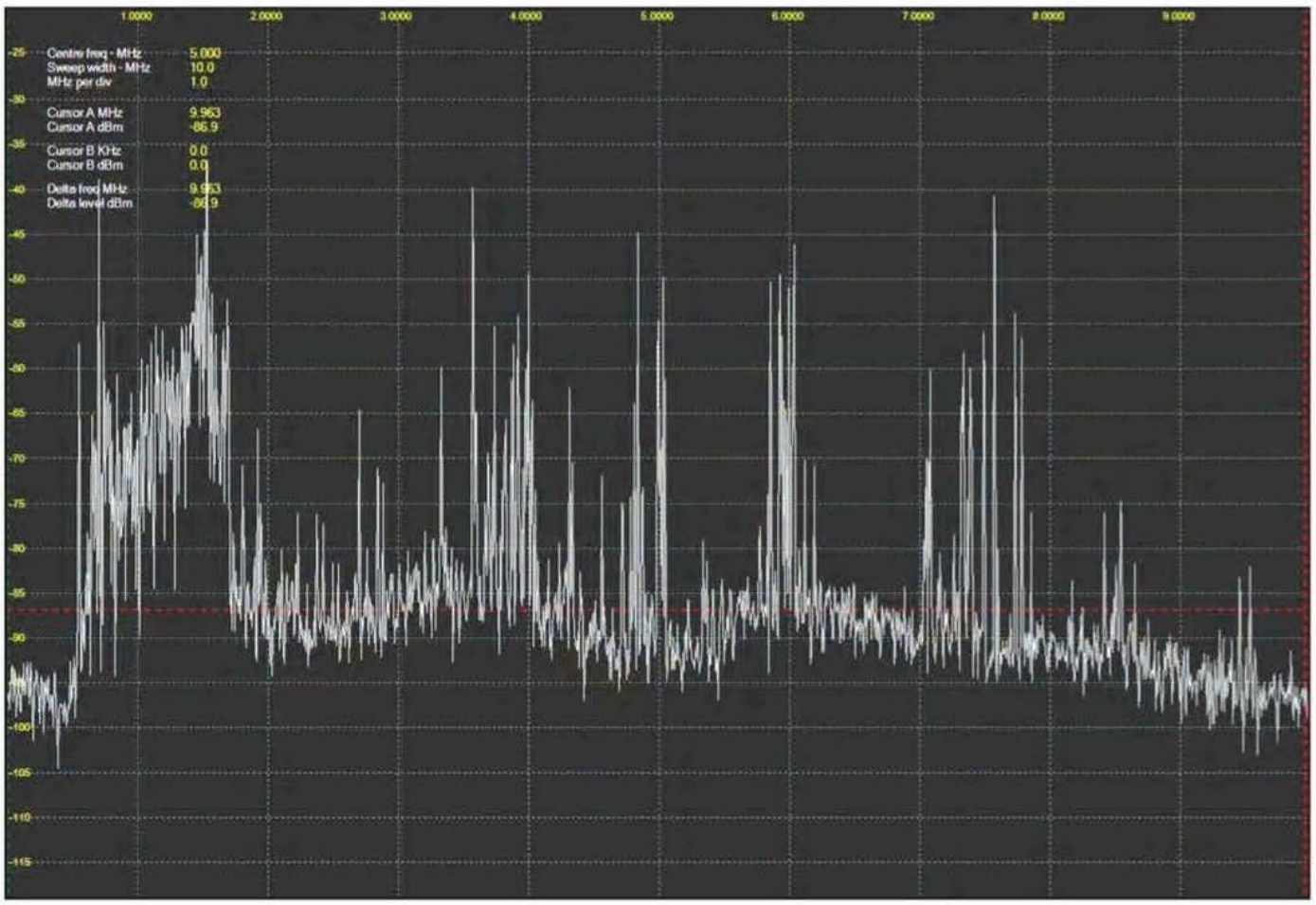

Figure 1. The RF spectrum at the author's QTH with no BCI filter. The many strong signals in the AM broadcast band are visible at the left. Compare with Figure 5 to see the filters effect.

addition, some SSB stations sounded slightly distorted, especially at low volume levels, with a "gritty/scratchy" sound. The interference was pervasive and could be heard virtually everywhere on the amateur bands. This occurred with both the native "stock" µBITX audio and the newer JackAl DSP audio.

Investigation of the signals directly from the antenna using an RSP1-based spectrum analyzer clearly indicated a very strong group of signals across the broadcast band (550 kHz to 1.6 MHz), with levels up to 20 dB above most 80-, 40-, and 20-meter signals, as shown in *Figure 1*.

What is going on here? Looking at the antenna SWR in the AM broadcast band revealed a strong resonance around 600 kHz. Apparently, the resonance-enhanced BC band signals were overloading the stock µBITX front end

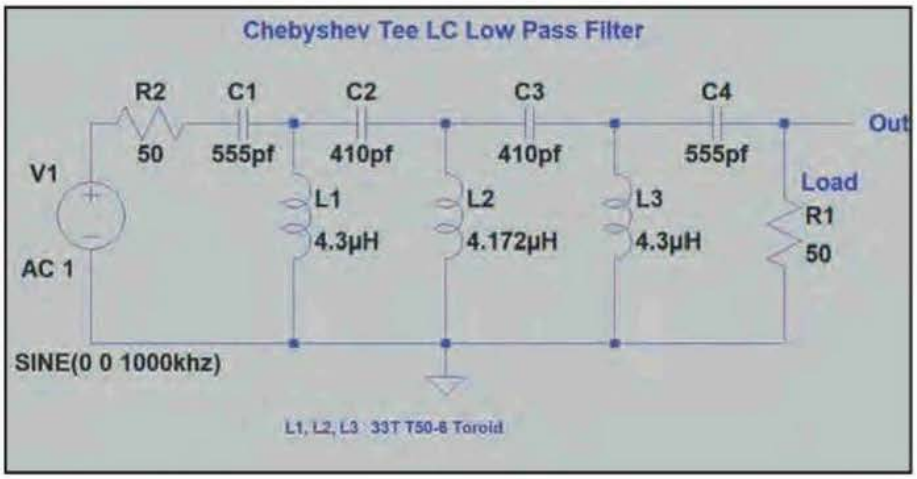

Figure 2. Broadcast interference filter schematic.

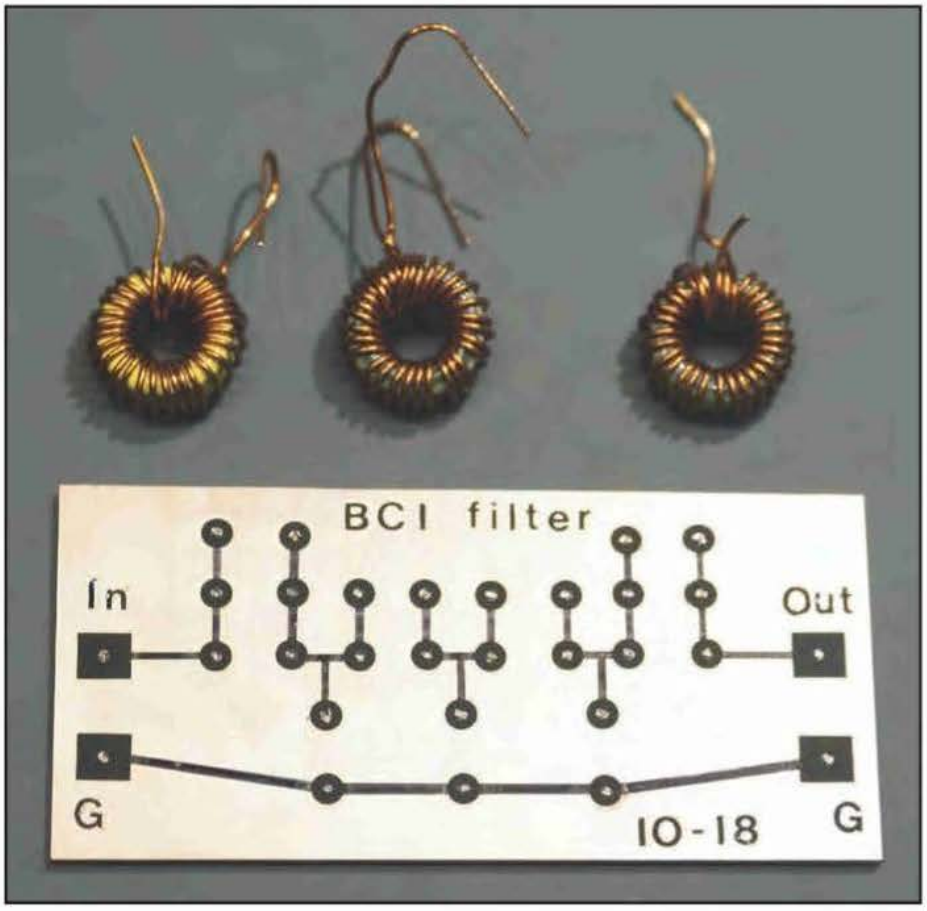

Photo A. Printed circuit board and finished toroids for the filter.

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and finding their way into the μBITX audio circuits, adding background noise across the amateur bands. The μBITX does not have filtering in front of the first converter stage, so strong signals from outside of the amateur bands are not rejected. Normally, unless one is located right next to a BC station, this should not be a problem. Interestingly, though, my location is 20 miles away from the nearest BC station. Not only that, the strongest BC signal from my antenna is from a 5-kilowatt AM station. This situation clearly emphasizes the effect of resonant antennas on signal reception. Imagine my surprise in finding that I needed a BCI filter. (First surprise.)

The Solution

The obvious solution is to insert a BCI filter between the antenna and μBITX. I designed a seven-component Chebyshev Tee topology LC high-pass filter for the QRP transceiver. Cutoff frequency was selected at 2 MHz for good

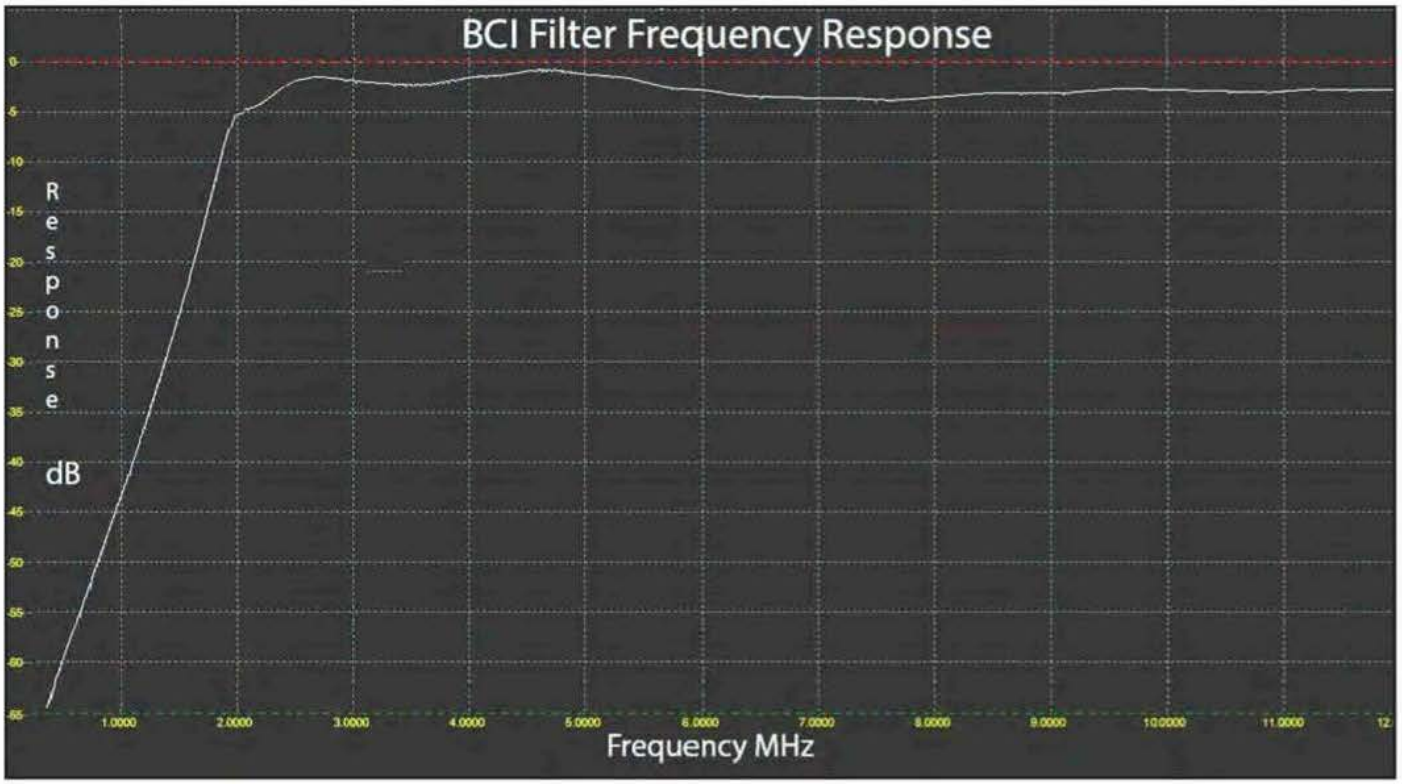


Figure 3. Calculated BCI filter response.

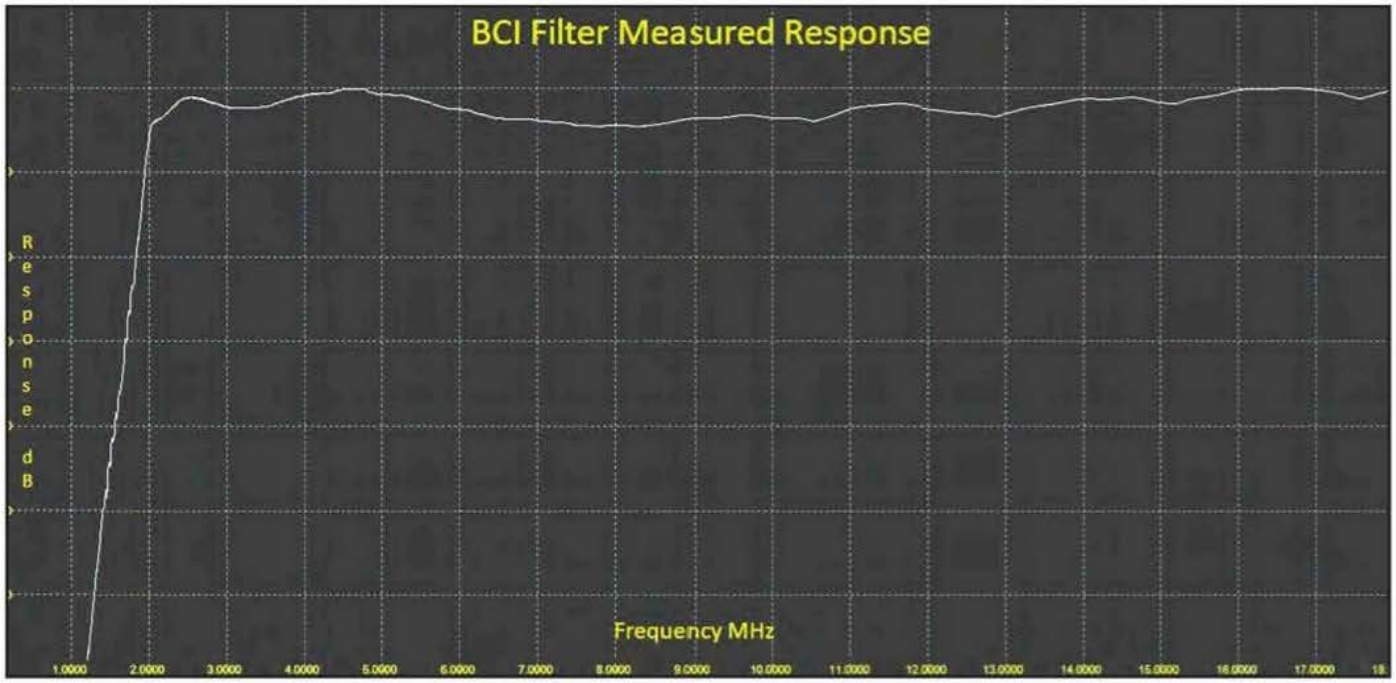
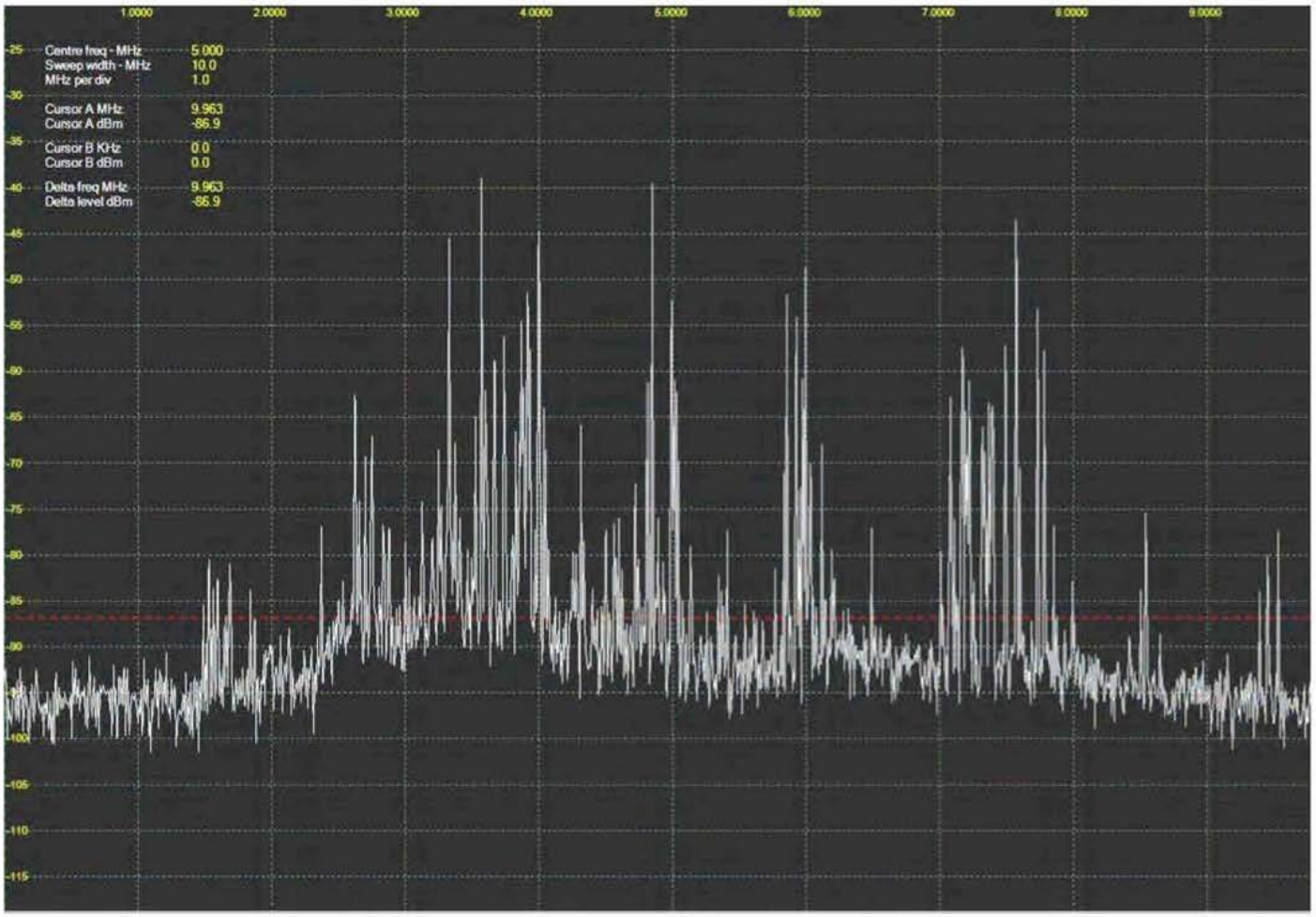


Figure 4. Measured BCI filter response.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Cursor B KHz 0.0
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Delta freq MHz 9.963
Delta level dBm -86.9

Figure 5. RF spectrum with BCI filter inline. Compare with Figure 1.

effect at the BC band, yet still allowing 80-meter reception as well as some of the 160-meter band. My antenna is not effective at 160 meters, so this band was not considered in selecting the pass-band for my application. The filter circuit is shown in *Figure 2*.

Chebyshev filters have steep skirts, but the top passband has some ripple. For this application, some variation near the cutoff frequency should have negligible effects on actual receiver performance. If a flatter top is desired, the Butterworth topology might be considered.

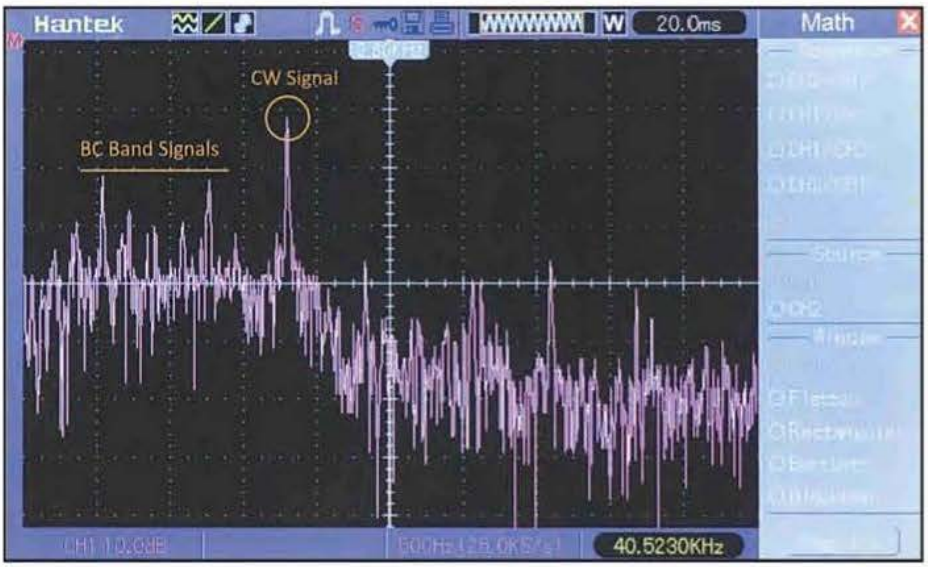

Figure 6. Audio spectrum CW signal without the BCI filter. Compare with Figure 7.

A prototype version was built with some T50-6 toroids and silver mica and ceramic capacitors I had on hand. A simple PC board is shown in *Photo A*, which allows the capacitors to be paralleled to achieve the required values. The inductor value of 4.3 µH is achieved with approximately 33 turns of 0.7-mm wire on the T50-6 toroid. The circuit is simple enough that you can also build it with perf board.

To test the filter's power handling capacity during transmit, it was subjected to 200 watts CW for one minute. The maximum component temperature reached was about 130° F. Under normal CW use at 20 WPM, also at 200 watts, the temperature only reached a bit over 100° F after one minute. Conservatively, the filter should be suitable for use with 100-watt transceivers.

Performance

Figure 3 shows the LTSpice frequency response simulation of the BCI filter. The design calls for some ripple in the passband, which should be undetectable in practice. *Figure 4* shows the actual measured response, using reac-

tive parts selected to be as close as possible to the design values. Insertion loss is no more than a few dB.

Finally, *Figure 5* shows the antenna signal spectrum with the BCI filter inline. The 500- to 1600-kHz BC band signals are attenuated by about 60 dB. In use, the µBITX audio quality is considerably improved; low-level background BC signals are gone, and the audio distortions are eliminated.

A second and additionally surprising effect is a slight reduction in the noise across the entire spectrum. A reduction in the noise floor of approximately 5dB is clearly shown in the spectrum plot and is noticeable in actual usage. The insertion loss of the BCI filter accounts for a portion of the noise reduction; however, it appears that the BCI filter really does reduce the noise floor slightly more than the insertion loss would suggest.

Finally, using a 40-meter CW signal as a reference, the audio spectrum with and without the BCI filter is shown in *Figures 6* and *7*.

Without the BCI filter, AM BC stations are clearly heard in the background. The spectrum shows the BC signals are 10 to 18 dB above the general noise floor. The inclusion of the BCI filter completely removes the interference and the CW signals are "clean."

Conclusion

The µBITX appears to be vulnerable to overload from BCI, affecting audio clarity and noise floor. The inclusion of a simple BCI between the antenna and µBITX solves the problem, including a slight reduction of the general noise floor. Not all µBITX installations will suffer from BCI, but if yours shows symptoms like mine did, the solution is simple and straightforward. However, just because you don't experience BCI with your receiver right now doesn't isolate you from the problem. Many who have inexpensive QRP rigs do so because they use them on Field Day, during vacations, and on other trips. So, the absence of BCI at your home location doesn't mean you won't experience it at some future location. This BCI filter is pretty cheap insurance that broadcast interference won't be a problem...ever. The surprising interference from broadcast stations 20 miles away clearly demonstrates the effect of resonant antenna systems on performance.

To finish the project, I re-used a small metal case to house the BCI filter, also including a DPDT by-pass switch, as shown in *Photos B* and *C*.

Note:

1. JackAI is an add-on board to the µBITX transceiver that provides IF AGC, a high-resolution touch screen and many post-processing features. It is being designed by Jack Purdum, W8TEE, and the author. See <https://tinyurl.com/ya9yxrwc> for details.

Photos B and C. Finished BCI filter in case. The author repurposed a case he already had on hand.

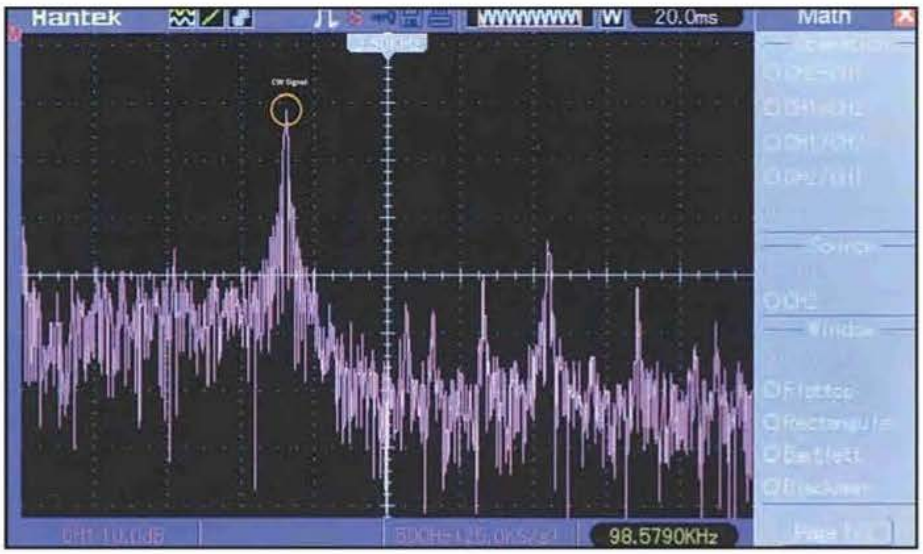

Figure 7. Audio spectrum CW signal with the BCI filter. Compare with Figure 6.